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PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

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Patent- og Varemærkestyrelsen
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02 December 2004

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PATENT- OG VAREMÆRKESTYRELSEN

IMPROVED RESONANCE SECURITY TAG AND METHOD OF PRODUCING SUCH A TAG

TECHNICAL FIELD

The present invention relates to a resonance security tag of the kind set forth in the preamble of claim 1 and a method of producing such a tag.

BACKGROUND ART

Resonance security tags of this kind are e.g. known to be used in electronic article surveillance systems (EAS systems) in order to detect unauthorised removal of articles from shops, stores or warehouses, and such resonance security tags are produced in large numbers on a dielectric foil material which is provided with conductive material layer patterns on both sides for forming an inductor and a capacitor forming a resonance circuit having a suitable resonance frequency and to be detected by means of suitable equipment positioned at the exit from the premises. A resonance security tag of this kind is e.g. known from EP-0,285,559.

DISCLOSURE OF THE INVENTION

It is the object of the present invention to provide a resonance security tag of the kind referred to above, with which it is possible to improve the detection level and at the same time possibly reducing or maintaining the small size of the resonance security tag, and this object is achieved with a resonance security tag of the kind, which according to the present invention also comprises the features set forth in the characterising clause of claim 1. With this arrangement, the central part of the inductor is made free in order to allow penetration of the magnetic flux through the inductor, whereby a higher detection rate is achieved. Furthermore, the present invention relates to a method of producing such a tag.

Preferred embodiments of the resonance security tag in accordance with the present invention, the advantages of which will be evident from the following description, are revealed in the sub-ordinate claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed part of the present description, the invention will be explained in more detail with reference to the exemplary embodiments of a resonance security tag according to the invention shown in the drawings, in which

Fig. 1 schematically shows a tag positioned between a transmitter and a receiver at the exit from the store or like for detecting the presence of the tag at the exit,
Fig. 2 schematically shows an equivalent circuit diagram of the situation shown in Fig. 1 for explaining the parameters for improving the detection level,
Fig. 3 shows the conductive material layer pattern on a first side of the dielectric foil material of a resonance security tag in accordance with the present invention,
Fig. 4 shows the conductive material layer pattern on both sides of the dielectric foil material of a resonance security tag in accordance with the present invention,
Fig. 5 shows schematically in a perspective view a partially folded cut free capacitor of a resonance security tag in accordance with Figs. 3 and 4,
Fig. 6 shows the resonance security tag of Fig. 5 with the capacitor in a completely folded position,
Fig. 7 schematically shows suggested instruments for performing the folding of the capacitor, and
Fig. 8 shows an alternative embodiment of the resonance security tag specially formed to be positioned on or inside a CD or DVD in accordance with a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figs. 1 and 2, the quality of a resonance security tag is discussed in the following. In Figs. 1 and 2, the tag 1 is positioned between a transmitter Tx in an electronic article surveillance system (EAS system), and a receiver Rx of said

system. The transmitter transmits a radio frequency signal within a specific frequency range and whenever a tag with at resonance frequency within this range is within the range of the transmitter and the receiver, the receiver will be able to detect the resonance frequency of the tag.

The detection rate or quality will be dependent on the Q-value of the resonance circuit and the physical size thereof. The formula

$$Q = \frac{1}{r}\sqrt{\frac{L}{C}} \quad (1)$$

indicates that in order to obtain a high Q-value, it is desired to have a small value of r, a high value of L and a small value of C. A low value of r can be obtained by choosing a conductive material layer in the tag like e.g. silver and a high value of L can be obtained by providing several windings in the inductor and at the same time the capacitor can be chosen with a small capacitance C.

In practice, however, this is not how it is done due to the fact that the price of silver is too high and many windings of the inductor coil will demand more material and surface area for the tag, which would increase the price of the tag. Furthermore, if many small windings are chosen in order to save material costs for the conductive material layer, the value of r will increase. If a very small value of C of e.g. 10pF is chosen, the resonance circuit will be sensitive to external influence such as stray capacities, which would change the resonance frequency.

As can be seen from the above, the design of the resonance circuit for an EAS system is a compromise between price and size, among other things. In the market there is a wish for a cheap tag as well as a small tag with a high rate of detection and Q-value. Accordingly, the resonance circuit normally comprises a dielectric foil material 2 of polypropylene or polyethylene provided with an electrically conductive material layer pattern on both sides, said conductive material usually being of aluminium.

The electrical equivalent diagram shown in Fig. 2 corresponds in principle to an EAS system and the mutual induction coefficients between the inductors L1, L2 and L3

are M12 and M23, respectively. The loss resistance in the resonance circuit in the tag is represented by r. The input resistance in the measuring circuit is represented by R. The measured voltage Vm represents the signal strength from the resonance security tag. The resonance circuit L2,r,C is positioned between the transmitter coil L1 and the receiver coil L3. The formula for the received signal strength Vm is

$$Vm = \omega_0\,(M12 \cdot M23/L1) \cdot \frac{V1}{r} \qquad (2)$$

where ω_0 is equal to $2\,\pi\,f_0$ (f_0 is the resonance frequency).

V1 is the voltage of the signal generator. When the coils L1, L2 and L3 (the cross-sections S1, S3 > S2), are arranged as shown, the mutual inductances are

$$M12 = K12\,\sqrt{S2\,L2} \text{ and } M23 = K23\,\sqrt{S2\,L2} \qquad (3),$$

where K12 and K23 are constants. Using (2) and (3), we have:

$$Vm = K12\,K23\,(V1/L1)\,(\omega_0\,L2/r)\,S2 = K \cdot Q \cdot S \qquad (4)$$

K is a constant and Q is a measure for the quality of the resonance circuit

$$Q = \frac{1}{r}\sqrt{\frac{L}{C}}$$

S is the area surrounded by the magnetic flux. From the above it can be seen that Vm is proportional to Q · S.

In order to improve the tag, it is possible to increase Q or S or both.

The magnetic flux, which has to pass through the centre of the coil, is partially blocked by the capacitor in this position in a normal tag, referring to figures 3 and 4. In order to increase the magnetic flux through the coil centre, it is desired to make the area of the capacitor as small as possible. As mentioned earlier, a certain minimum size of the capacitor is given, which leads to a restriction of the area in the

centre of the coil which is free to allow the magnetic flux through the coil. The present invention removes the capacitor from the centre of the coil, whereby the magnetic flux through the coil centre is increased and thus the detection rate for the EAS system is increased considerably.

In Fig. 3 is shown the conductive material layer pattern on the first side of the dielectric foil material 2, which is formed to provide an inductor 3, a first capacitor plate 4 connected to a first end of the inductor 3 and positioned inside the inductor 3, and a first connection element 5 connected to an opposite end of the inductor 3. In Fig. 4 the conductive material layer pattern on the second, opposite side of the dielectric foil material 2 is shown superposed on the pattern of Fig. 3. The conductive material layer pattern on the second side of the dielectric foil material 2 is formed to provide a second capacitor plate 6 confronting the first capacitor plate 4 and a second connection element 7 connected to the capacitor plate 6 and confronting the first connection element 5. Furthermore, the second connection element 7 is formed with a widening 11, which provides a patch of conductive material layer with a form and size corresponding to the form and size of the first and the second capacitor plate 4, 6.

As shown schematically in Fig. 5, the capacitor plates 4, 6 have been cut 9 along part of the circumference of the first and second capacitor plates 4, 6 in order to fold the capacitor 4, 6 away from the central position inside the inductor 3. As shown in Fig. 6 the cut-free capacitor 4, 6 is folded completely along the folding line 10 over to overlay the widening 11.

In order to minimise the change in resonance frequency by the folding of the capacitor 4, 6, the capacitor is folded to the second side of the dielectric foil material 2. Moreover, the provision of the widened-out patch 11 further decreases the change in resonance frequency when folding the capacitor 4, 6 to this side.

The electrical contact 8 between the first and second connection elements 5, 7 is preferably provided by irregular holes through the dielectric foil material 2 in the area of the first and second connection element 5, 7 before the folding of the capacitor plates 4, 6.

The cut 9 along part of the circumference of the first and second capacitor plates 4, 6 can be provided by mechanical means, by laser cutting, etc. The first part of the folding of the capacitor 4, 6 may be provided by mechanical means or by means of a jet of air, etc. An example of mechanical means for providing the folding of the capacitor 4, 6 is shown in Fig. 7, in which a folding tool 12 is positioned stationary over the foil material 2 and the foil material is moved towards this folding tool which folds the turned up capacitor 4, 6. In order to move the folded capacitor 4, 6 into intimate contact with the upper side of the tag, a further roller-formed tool 13 is positioned immediately after the folding tool 12 seen in the movement direction of the foil 2.

The tag in accordance with the present invention is especially suited to be used as an EAS tag for a CD or DVD due to the fact that the hole in the middle can be positioned over the hole in the CD or DVD and the coil can be positioned so as to surround this hole in a position in which the CD or DVD has no metallic layer and thus allows the radio frequency field to pass through the area where the tag is positioned. This would not have been possible with a conventional tag due to the fact that a tag of this small size would not be detectable in an EAS system when the tag is produced in accordance with the conventional technique.

The tag in accordance with the present invention can, as shown in Fig. 8, be positioned centrally in a CD or DVD and may be integrated into the DVD between the layers of the DVD. In this situation the EAS tag cannot be removed without destroying the DVD.

Above, the invention has been described in connection with preferred embodiments thereof, however, many modifications may be envisaged by a person skilled in the art without departing from the scope of the following claims.

CLAIMS:

1. Resonance security tag (1) comprising a dielectric foil material (2) provided with conductive material layer patterns (3-7) on both sides, said conductive material layer pattern on a first side of the dielectric foil material (2) being formed to provide an inductor (3), a first capacitor plate (4) connected to a first end of the inductor (3) and positioned inside the inductor (3), and a first connection element (5) connected to an opposite second end of the inductor (3),
the conductive material layer pattern on a second side of the dielectric foil material (2) being formed to provide a second capacitor plate (6) confronting the first capacitor plate (4) and a second connection element (7) connected to the second capacitor plate (6) and confronting the first connection element (5),
the first and second connection elements (5, 7) being electrically connected (8), characterised by the dielectric foil material (2) being cut (9) along part of the circumference of the first and second capacitor plates (4, 6) and the cut-free capacitor (4, 6) being folded away from the position inside the inductor (3), thus leaving this part free for the penetration of magnetic flux through the inductor (3).

2. Resonance security tag in accordance with claim 1, characterised by the cut-free capacitor (4, 6) being folded to the second side of the dielectric foil material (2).

3. Resonance security tag in accordance with claim 1 or 2, characterised by the second connection element (7) being connected to the second capacitor plate (6) by providing the conductive material layer on the second side of the dielectric foil material (2) with a widening (11), which provides a patch of conductive material layer with a form and size corresponding to the form and size of the folded over first and second capacitor plates (4, 6).

4. Resonance security tag in accordance with any of the preceding claims, characterised by the conductive material layer patterns (3-7) being formed in such a way that the tag can be positioned on or inside a CD or DVD with the hole from the folded capacitor (4, 6) positioned around the central hole in the CD or DVD.

5. Method of producing a resonance security tag (1) in accordance with claim 1 or any of the claims dependent thereon, said method comprising the steps of providing a dielectric foil material (2) with conductive material layer patterns (3-7) on both sides, said conductive material layer patterns being formed to provide an inductor (3) and a capacitor (4, 6) forming a resonance circuit with the capacitor (4, 6) positioned inside the inductor (3), characterised by further comprising the step of cutting (9) the dielectric foil material (2) along part of the circumference of the capacitor (4, 6) and folding the cut-free capacitor (4, 6) away from the position inside the inductor (3), thus leaving this part free for the penetration of magnetic flux through the inductor (3).

6. Method in accordance with claim 5, characterised by the folding step being performed to fold the cut-free capacitor (4, 6) to that side of the tag, which is opposite the side on which the conductive material layer pattern is formed to provide the inductor (3).

7. Method in accordance with claim 5 or 6, characterised by the folding being performed by producing a preliminary folding using a jet of air or mechanical means to turn up the capacitor (4, 6), and followed by the passage of the security tag (1) past a folding tool (12) and a roller (13), whereby the turned up capacitor (4, 6) is completely folded and pressed into intimate contact with the surface of the resonance security tag (1).

IMPROVED RESONANCE SECURITY TAG AND METHOD OF PRODUCING SUCH A TAG

ABSTRACT OF THE INVENTION

A resonance security tag (1) comprises a dielectric foil material (2) provided with conductive material layer patterns (3-7) on both sides. The conductive material layer patterns are formed to provide an inductor (3) and a capacitor (4, 6) positioned inside the inductor (3), and mutually connected to form a resonance circuit. By cutting (9) the capacitor (4, 6) free of the dielectric foil material (2) and folding the capacitor (4, 6) away from the position inside the inductor (3), this part is left free for the penetration of magnetic flux through the inductor (3), whereby the detection level is improved and a possibility of reducing the size of the resonance security tag is provided.

(It is suggested that Figure 5 be published with the Abstract).

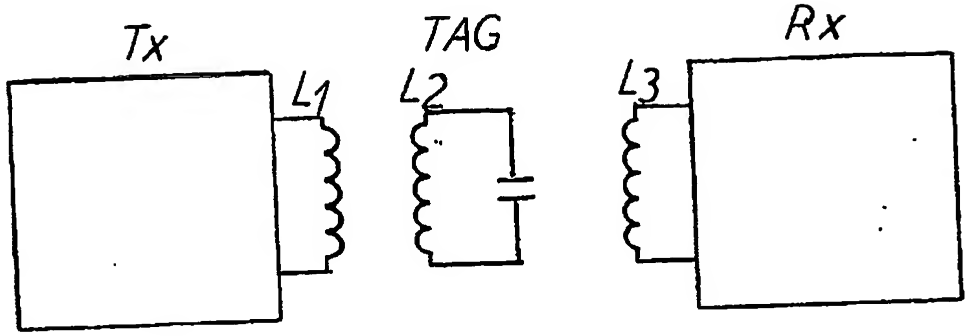

FIG 1

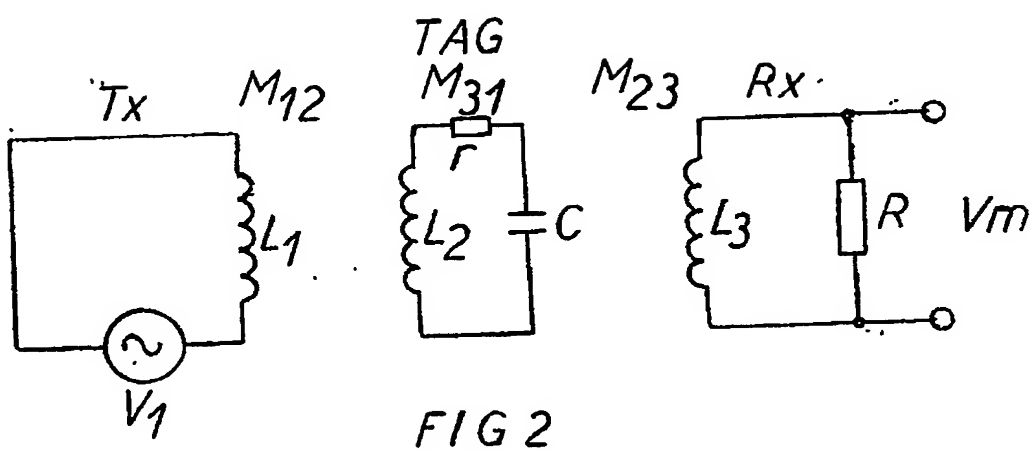

FIG 2

Modtaget

16 DEC. 2003

PVS

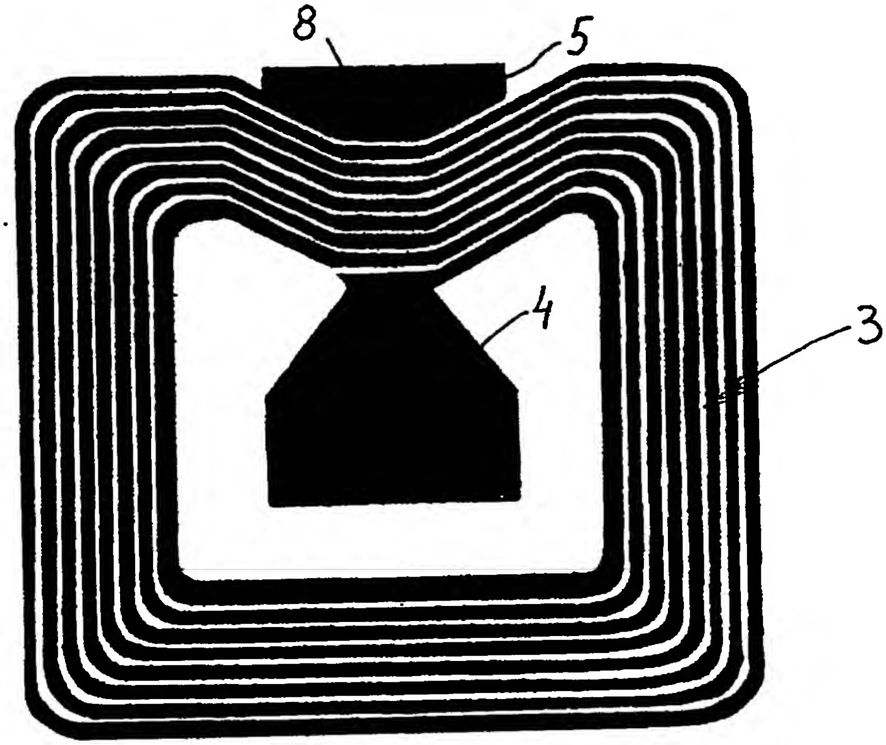

Fig.3.

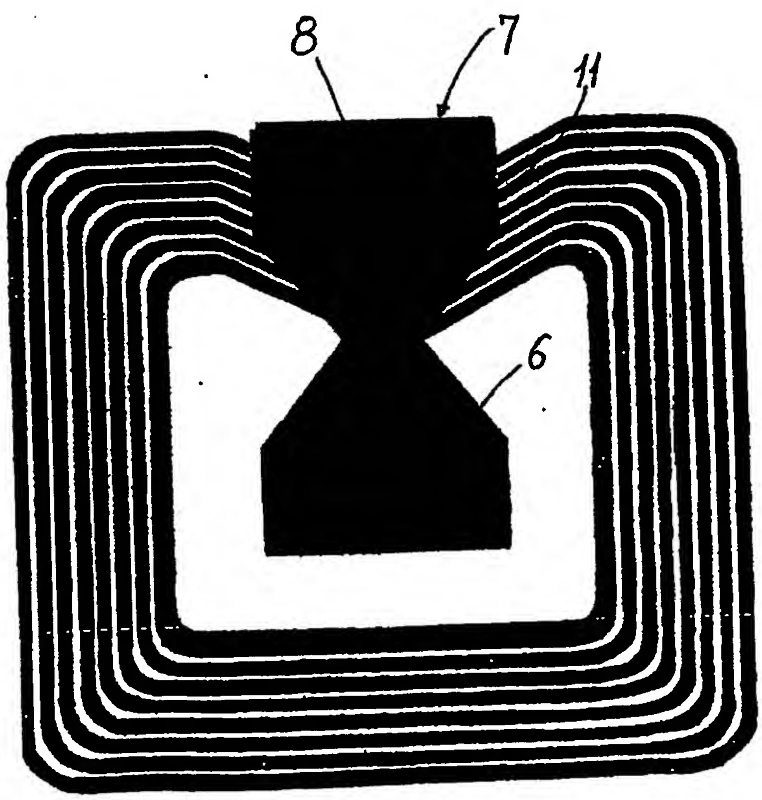

Fig.4.

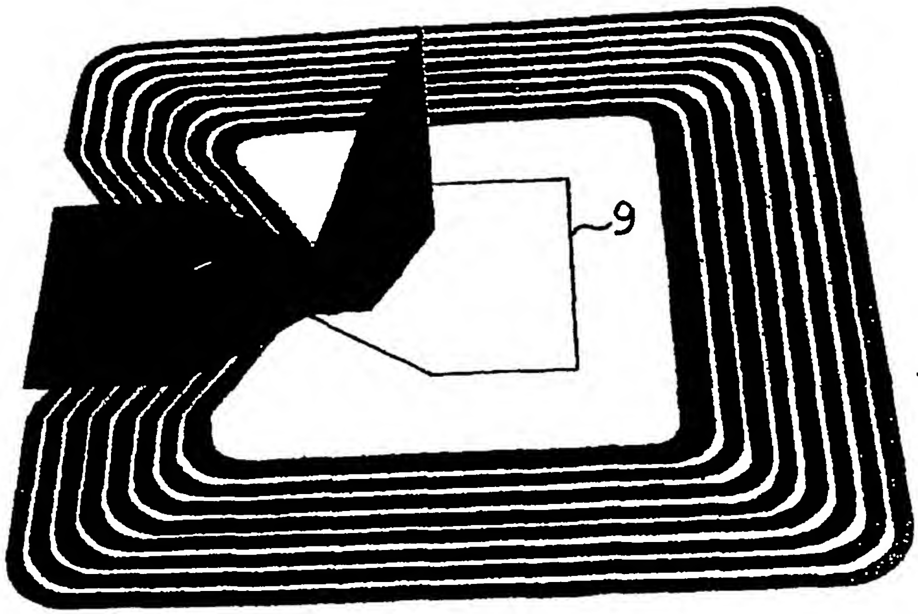

Fig. 5.

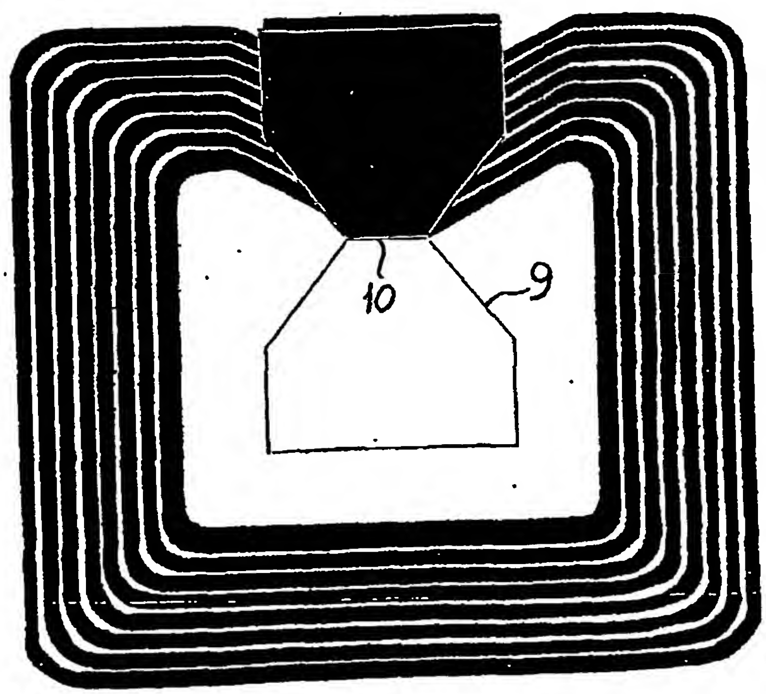

Fig. 6.

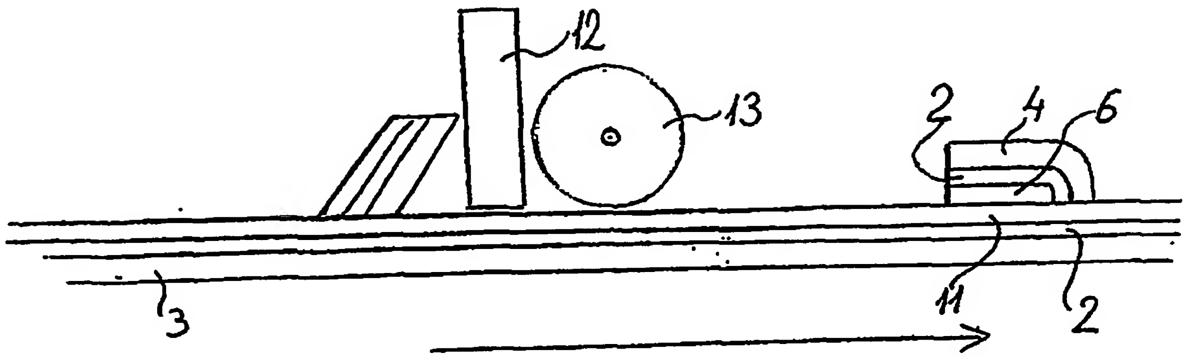

Fig.7.

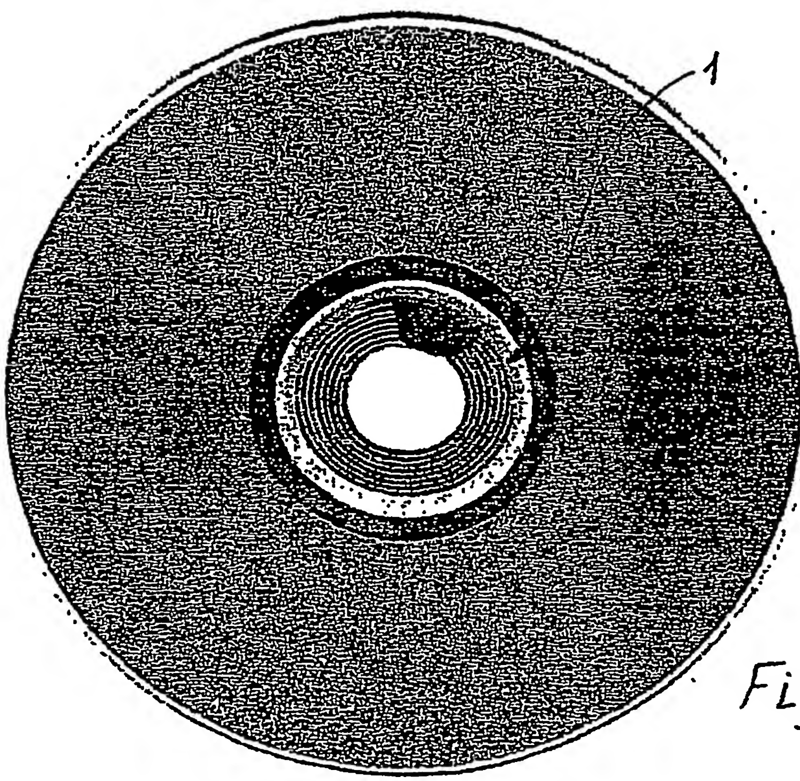

Fig.8.